



Patterns of Dual Use of Cigarettes and Smokeless Tobacco among U.S. Males: Findings from National Surveys

Citation

Tomar, Scott L., Hillel R. Alpert, and Gregory N. Connolly. 2009. Patterns of dual use of cigarettes and smokeless tobacco among U.S. males: Findings from national surveys. *Tobacco Control* 19(2): 104-109.

Published Version

doi:10.1136/tc.2009.031070

Permanent link

<http://nrs.harvard.edu/urn-3:HUL.InstRepos:8592158>

Terms of Use

This article was downloaded from Harvard University's DASH repository, and is made available under the terms and conditions applicable to Other Posted Material, as set forth at <http://nrs.harvard.edu/urn-3:HUL.InstRepos:dash.current.terms-of-use#LAA>

Share Your Story

The Harvard community has made this article openly available.
Please share how this access benefits you. [Submit a story](#).

[Accessibility](#)



Patterns of dual use of cigarettes and smokeless tobacco among US males: findings from national surveys

Scott L Tomar,¹ Hillel R Alpert,² Gregory N Connolly²

¹Department of Community Dentistry and Behavioral Science, University of Florida College of Dentistry, Gainesville, Florida, USA

²Department of Society, Human Development, and Health, Division of Public Health Practice, Harvard School of Public Health, Boston, Massachusetts, USA

Correspondence to

Dr Scott L Tomar, Department of Community Dentistry and Behavioral Science, University of Florida College of Dentistry, 1329 SW 16th Street, Suite 5180, PO Box 103628, Gainesville, FL 32610-3628, USA; stomar@dental.ufl.edu

Received 16 April 2009

Accepted 4 November 2009

Published Online First

11 December 2009

ABSTRACT

Background In the USA, consumption of moist snuff continues to increase and cigarette manufacturers now control nearly its entire market. Manufacturers have developed new products that represent cigarette brand extension and in test marketing are promoting dual use of cigarettes and snuff. This study examined patterns of concurrent use of smokeless tobacco (ST) and cigarettes among young people and adults in the USA just before cigarette companies' control of the nation's ST market.

Methods Data were drawn from four US nationally representative surveys. Stratified analyses applied sampling weights and accounted for the complex sample designs.

Results Cigarette smoking was substantially more prevalent among young males who used ST than among those who did not. Among adult males, those who smoked daily were less likely than others to have used snuff every day. Men who used moist snuff daily had the lowest prevalence of daily smoking, but the prevalence of daily smoking was relatively high among men who used moist snuff less than daily. Unsuccessful past-year attempts by daily smokers to quit smoking were more prevalent among non-daily snuff users (41.2%) than among those who had never used snuff (29.6%).

Conclusions Although dual daily use of ST and cigarettes is relatively uncommon in the USA, concurrent ST use is more common among adolescent and young adult male smokers than among more mature tobacco users. Among adult males, daily smoking predominates and non-daily ST use is very strongly associated with current smoking. Adult male smokers who also use ST daily tend to have relatively high levels of serum cotinine and high prevalence of a major indicator for tobacco dependence.

BACKGROUND

Smokeless tobacco (ST) products include chewing tobacco, dry snuff and moist snuff. Consumption of chewing tobacco in the USA decreased from 47 million to 36 million pounds, and dry snuff from 3.5 million pounds to 2.2 million pounds from 2000 to 2006.¹ However, during the same time period, consumption of moist snuff increased from 61.5 million pounds to 77.4 million pounds.¹ Recently, cigarette and ST manufacturers have introduced a drier form of moist snuff called snus (20% moisture content vs 50% in traditional moist snuff), which is packaged in a pouch, often flavoured, and placed in the upper lip to reduce spitting. Snus has gained popularity among boys and men in Sweden, among whom its prevalence of use is greater than cigarette smoking.²

For decades, the US ST market was dominated by a small number of companies that sold only ST and had no financial interest in selling cigarettes. That situation changed with the acquisitions of the Conwood Company in 2006 by Reynolds American, Inc³ and the US Smokeless Tobacco Company (USSTC) in 2008 by Altria Group, the parent company for Philip Morris USA.⁴ Cigarette companies have also introduced new ST products, including moist snuff and snus, sold under cigarette brand names such as Marlboro and Camel. The recent entry by the cigarette industry into the US ST market, and expanded promotion of existing and new ST products, may have far-reaching public health implications. This new development has the potential to encourage increased ST use among young people and dual use of ST and cigarettes among smokers, while slowing reductions in smoking prevalence and undermining cessation.

Few studies have been conducted regarding the extent of dual use of ST and cigarettes in the USA,^{5–8} and none has examined detailed patterns across multiple population-based data sources. The purpose of this study was to examine patterns of concurrent use of ST and cigarettes among young people and adults in the USA. The data were primarily collected before the recent acquisitions of the US ST companies by cigarette manufacturers, and the analyses therefore may be viewed as a baseline measure of the extent of dual product use just before the entry of the major cigarette companies into the nation's ST market. The analysis focused specifically on snuff, where possible. It also analysed levels of serum cotinine and markers of nicotine addiction such as time to first cigarette after waking among exclusive smokers and dual product users. Because use of ST in the USA is relatively rare among females, all analyses in this study were limited to males.

METHODS

Data sources

Data for this study were drawn from four US nationally representative surveys. We include four data sources because each survey has its particular strengths and limitations and no single data source adequately covers the full range of ages and variables related to dual use of cigarettes and ST. For example, the Current Population Survey Tobacco Use Supplement provides extensive detail on tobacco use, but is not anonymous and does not include people under age 16. School-based surveys such as the Monitoring the Future Study and the National Youth Tobacco Survey are anonymously



This paper is freely available online under the BMJ Journals unlocked scheme, see <http://tobaccocontrol.bmj.com/site/about/unlocked.xhtml>

administered and reach younger people but provide more limited detail on pattern of tobacco use. In addition to self-reported data, the National Health and Nutrition Examination Survey collects biological specimens that enables measurements such as serum cotinine levels, but has a limited sample size for subgroup analyses. These surveys use different sampling schemes, methodologies and questions to collect data on tobacco use and other variables included in this study. The sources and variables examined are briefly summarised below.

Current Population Survey—Tobacco Use Supplement

The US Bureau of the Census and the US Bureau of Labour Statistics have conducted the Current Population Survey (CPS) for more than 50 years to assess employment in the USA (US Census Bureau 2006 <http://www.census.gov/prod/2006pubs/t6-66.pdf>). The sample is drawn from the US civilian, non-institutionalised population age 15 years or older. Data are collected monthly through household interviews. Questions on tobacco use were added as a National Cancer Institute-sponsored Tobacco Use Supplement (TUS) to the monthly CPS in May and August 2006 and January 2007, which are the most recent data available at this time. Data for those 3 months were combined and used to produce national estimates. Although CPS includes both self-reported and proxy-reported data, analysis in this study included only self-reported data. Further information on the CPS-TUS is available at: <http://riskfactor.cancer.gov/studies/tus-cps/>.

Monitoring the Future Survey

Supported by grants from the National Institute on Drug Abuse, the University of Michigan's Institute for Social Research has surveyed nationally representative samples of high school seniors in the spring of each year since 1975 as part of the Monitoring the Future (MTF) Survey.⁹ Beginning in 1991, surveys also have been conducted among 8th- and 10th-grade students. Multistage sampling designs were used to randomly select students in public and private schools within the 48 contiguous states. Self-administered questionnaires were distributed to students in classrooms by trained personnel, and standardised procedures were followed. This report uses MTF Survey data from public use data tapes for 2005 and 2006. A detailed description of the MTF survey is available elsewhere.⁹

National Health and Nutrition Examination Survey

The National Health and Nutrition Examination Survey (NHANES) is a programme of studies conducted by the National Center for Health Statistics to assess the health and nutritional status of adults and children in the USA. As part of the NHANES, venepuncture is performed to collect a blood sample from each participant. The blood samples are subsequently assayed for a wide range of biochemical substances, including cotinine, a major metabolite of nicotine and a biomarker for nicotine exposure. The NHANES is designed to be representative of the civilian, non-institutionalised US population. The analyses in this study included data from 1999 to 2006 for men aged 20 years and older. Further details on NHANES are available at <http://www.cdc.gov/nchs/nhanes.htm>.

National Youth Tobacco Survey

The National Youth Tobacco Survey (NYTS) has been conducted by the Centers for Disease Control and Prevention since 1999 to provide estimates of current use of tobacco products among US middle school and high school students. The NYTS uses anonymous, self-completed survey instruments administered to students in a multi-stage probability sample of public and private

schools and classes. Further information on the NYTS is available at: http://www.cdc.gov/tobacco/data_statistics/surveys/NYTS/index.htm. This study included data from the 2006 NYTS.

Analysis

Each of the datasets was analysed for a number of parameters related to dual use of smokeless tobacco and cigarettes, including

- ▶ The prevalence of smoking, by smokeless tobacco use status
- ▶ The prevalence of smokeless tobacco use status, by smoking status
- ▶ Number of cigarettes smoked per day by daily smokers, by smokeless tobacco use status
- ▶ Sociodemographic characteristics of dual users
- ▶ Indicators of nicotine addiction, by smoking and snuff use status
- ▶ Interest and attempts to quit smoking among daily smokers, by snuff use status
- ▶ Biochemical markers of nicotine exposure, by smoking and snuff use status.

Most analyses involved bivariate contingency tables, generally stratified by demographic characteristics such as age or grade in school. All datasets included in this study used complex sample designs and applied sampling weights to account for differential probabilities of selection and participation. Therefore, all statistical analyses were conducted on weighted data by using SAS and SUDAAN software packages. *p* Values are reported for some specific comparisons of means or proportions, and we reported standard errors for estimated means and proportions to allow readers to calculate confidence intervals for those estimates.

RESULTS

Young people

Patterns of dual use

Based on the 2004 NYTS, 7.6% of male middle school students and 21.0% of male high schools students smoked on at least one of the 30 days preceding the survey (table 1). The prevalence of cigarette smoking was substantially higher among young males who used ST than among those who did not. For example, in the 2004 NYTS, 69.1% of boys in middle school who used ST every day also smoked during the preceding 30 days; 53.8% smoked every day. The pattern was similar for male high school students in the NYTS: about 60% of those who used ST in the past 30 days also smoked, compared to 17% of those who did not use ST. Although there were relatively few high school males in any grade who used ST on a daily basis, 8th graders in the 2005–2006 MTF Survey (data not shown) who used ST daily had a much higher prevalence of smoking one-half pack of cigarettes or more per day (10.8%) than did those who did not use ST at all (1.3%). The pattern was even more pronounced among 10th grade male students: 22.7% of daily ST users also smoked one-half pack of cigarettes or more per day, compared with 8.8% of less-than-daily ST users and 1.7% of those who did not use ST at all. Males in 12th grade who used ST on a daily basis did not differ appreciably on the prevalence of smoking one-half pack or more per day (22.8%) from those who used ST but less than daily (25.9%), but the prevalence of smoking one-half pack of cigarettes or more per day was about five times greater among ST users than among non-users (4.7%).

Based on the 2004 NYTS, 3.1% of male middle school students and 9.5% of male high school students used ST on at least one of the 30 days preceding the survey (table 2). ST use was substantially higher among young males who smoked than among non-smokers. For example, 27.7% of male middle school students who smoked daily during the preceding 30 days also had

Table 1 Cigarette smoking within the 30 days preceding the survey, by number of days of smokeless tobacco use within the preceding 30 days

Number of days used smokeless tobacco in the preceding 30 days	Unweighted sample size	Number of days smoked cigarettes of preceding 30 days					
		All 30 days		1–29 days		0 days	
		%	SE	%	SE	%	SE
Middle school*							
All 30 days	42	53.8	8.1	15.3	6.5	30.9	8.6
1–29 days	140	9.3	3.0	39.3	4.3	51.3	5.1
0 days	6327	0.7	0.1	5.5	0.4	93.9	0.5
Total	6509	1.2	0.2	6.4	0.5	92.4	0.6
High school†							
All 30 days	105	32.1	5.1	27.8	5.0	40.2	6.1
1–29 days	348	26.3	2.9	32.7	2.7	41.0	3.5
0 days	5804	5.4	0.6	11.6	0.7	83.0	1.0
Total	6257	7.6	0.7	13.5	0.7	79.0	1.2

Male middle school students (grades 6–8) and high school students (grades 9–12). National Youth Tobacco Survey, 2004.

* χ^2 test of independence between smokeless tobacco use and smoking = 39.65 (df = 4), $p < 0.00001$.

† $\chi^2 = 55.51$ (df = 4); $p < 0.00001$.

used ST during that time period, compared to 1.6% of those who had not smoked during the preceding 30 days. Differences between lighter smokers and heavier smokers in the prevalence of ST use were more pronounced among students in higher grades than in lower grades. For example, in grade 8 in the 2006 MTF Survey, 24.8% of males who smoked at least one-half pack of cigarettes per day also used ST during the preceding 30 days, while in grade 12 the corresponding prevalence was 40.8% (data not shown).

Adults

Patterns of dual use

Among males age 25 years or older in the 2006–2007 CPS-TUS, 16.0% smoked daily and 3.8% smoked on a non-daily basis (table 3). Men who used snuff on a daily basis had the lowest prevalence of daily smoking (7.3%), compared to 14.9% of men who had never used snuff, 37% of those who used snuff but less than every day and 29.1% of former snuff users.

Among men age 25 years or older in the 2006–2007 CPS-TUS, 0.6% of daily smokers also used snuff every day, compared to

Table 2 Smokeless tobacco (ST) use within the 30 days preceding the survey, by number of days of cigarette smoking within the preceding 30 days

Number of days smoked cigarettes in the preceding 30 days	Unweighted sample size	Number of days used ST of preceding 30 days					
		All 30 days		1–29 days		0 days	
		%	SE	%	SE	%	SE
Middle school							
All 30 days	79	26.3	6.0	20.0	5.5	53.7	7.9
1–29 days	443	1.4	0.6	15.7	2.3	82.9	2.4
0 days	5987	0.2	0.1	1.4	0.3	98.4	0.3
Total	6509	0.6	0.1	2.6	0.4	96.9	0.4
High school							
All 30 days	390	9.6	1.9	25.2	2.8	65.2	3.3
1–29 days	873	4.7	1.0	17.6	1.9	77.7	2.4
0 days	4994	1.2	0.3	3.8	0.5	95.1	0.6
Total	6257	2.3	0.4	7.2	0.7	90.5	1.0

Male middle school students (grades 6–8) and high school students (grades 9–12). National Youth Tobacco Survey, 2004.

Table 3 Smoking status of males aged 25 years or older, by snuff use status

Snuff use status	Unweighted sample size	Smoking status							
		Current daily		Current some day		Former		Never	
		%	SE	%	SE	%	SE	%	SE
Current daily	1100	7.3	0.9	7.7	1.0	34.9	1.7	50.0	1.8
Current some day	539	37.4	2.5	7.3	1.4	22.7	2.1	32.6	2.4
Former	5989	29.1	0.7	6.3	0.4	36.7	0.8	27.9	0.7
Never	59665	14.9	0.2	3.5	0.1	24.5	0.2	57.1	0.2
Total	67293	16.0	0.2	3.8	0.1	25.6	0.2	54.5	0.2

Current Population Survey Tobacco Use Supplement 2006–2007.

2.9% of non-daily smokers, 1.9% of former smokers and 1.3% of never smokers (table 4).

Selected sociodemographic characteristics of male daily smokers aged 25 years or older, by snuff use status, were analysed in the 2006–2007 CPS-TUS (data not shown). Daily dual product users were younger (mean = 42.45 years) than daily smokers who never used snuff (mean = 46.36 years; $p = 0.005$). Daily smokers who also used snuff on some days were significantly younger (mean = 38.58 years) than daily dual users ($p = 0.02$), former users (mean = 41.68 years; $p = 0.002$) and never users ($p < 0.00001$). Nearly all dual product users were white and were not of Hispanic ethnicity. Dual product use was most common in the southern region of the USA, including 53.6% of daily smokers who also used snuff daily and 45.2% of those who used snuff occasionally, compared to 38.0% of male daily smokers who had never used snuff. Dual product users also were over-represented in non-metropolitan areas. Among male daily smokers, the prevalence of concurrent snuff use was highest in Wyoming (11.8%), North Dakota (6.5%), Arkansas (5.9%) and West Virginia (5.6%) (data not shown).

Serum cotinine levels

Data on serum cotinine levels among male daily smokers were derived from the 1999–2006 National Health and Nutritional Examination Survey. Although the estimates are based on relatively small sample sizes, daily smokers who also used ST every day smoked about the same mean number of cigarettes per day as did daily smokers who used ST on some days or had never used ST (table 5). Daily dual product users had a significantly higher mean serum cotinine level than daily smokers who used ST on some days or never used it.

Smoking dependence and cessation

Table 6 presents data on a key indicator of tobacco dependence¹⁰ from the 2006–2007 CPS-TUS among men who smoke daily, by ST use status. Smoking within 30 minutes of waking was most

Table 4 Snuff use status of males aged 25 years or older, by cigarette smoking status

Smoking status	Unweighted sample size	Snuff use status							
		Current daily		Current some day		Former		Never	
		%	SE	%	SE	%	SE	%	SE
Current daily	10802	0.6	0.08	1.7	0.1	14.1	0.4	83.6	0.4
Current some day	2403	2.9	0.4	1.4	0.3	12.8	0.8	82.9	0.9
Former	19125	1.9	0.1	0.6	0.07	11.2	0.3	86.3	0.3
Never	34963	1.3	0.07	0.4	0.04	4.0	0.1	94.3	0.1
Total	67293	1.4	0.05	0.7	0.04	7.8	0.1	90.1	0.1

Current Population Survey Tobacco Use Supplement 2006–2007.

Table 5 Mean number of cigarettes smoked per day and mean serum cotinine level among male daily cigarette smokers* aged 20 years or older, by smokeless tobacco use status

Smokeless tobacco use	Unweighted sample size	Cigarettes per day		Serum cotinine (ng/ml)	
		Mean	SE	Mean	SE
Every day	11	17.06	3.79	344.20‡	40.02
Some days	22	17.75	1.62	215.79	22.69
Former	32	22.69†	1.70	276.74	22.54
Never	761	17.50	0.57	241.51	4.90
Total	826	17.73	0.51	244.72	4.51

National Health and Nutrition Examination Survey, 1999–2006.

*Excludes persons using cigars, pipes, or nicotine replacement pharmacotherapy.

†Significantly greater than some day smokeless tobacco use or never used smokeless tobacco ($p \leq 0.006$).

‡Significantly greater than some day smokeless tobacco use ($p = 0.01$) or never used smokeless tobacco ($p = 0.02$).

prevalent among daily smokers who also used ST daily (74.5%) and least prevalent among daily smokers who never used smokeless tobacco (63.8%).

Based on the 2006–2007 CPS-TUS, 30.0% of male daily smokers aged 25 years or older quit smoking for at least 1 day within the 12 months preceding the survey. Past-year quit attempts were more prevalent among non-daily snuff users (41.2%) than among daily smokers who had never used snuff (29.6%). That group also expressed a significantly greater

Table 6 Prevalence of selected indicators of addiction and quit attempts among of male daily smokers aged 25 years, by snuff use status

Indicator of addiction or quitting/snuff use status	Unweighted sample size	Percentage or mean	SE	p Value
First cigarette ≤ 30 minutes after waking				0.005
Current daily	75	74.5	5.6	
Current some days	197	68.7	4.1	
Former	1623	68.4	1.4	†
Never	8566	63.8	0.6	
Total	10461	64.6	0.6	
Quit smoking one or more days in past 12 months				0.05
Current daily	75	27.9	6.3	
Current some days	198	41.2	4.3	‡,§
Former	1638	31.1	1.4	
Never	8816	29.6	0.6	
Total	10727	30.0	0.5	
Seriously considering quitting smoking within next 6 months				0.0014
Current daily	74	36.5	6.5	
Current some days	196	48.0	4.3	¶
Former	1600	44.8	1.5	**
Never	8642	39.2	0.6	
Total	10512	40.2	0.6	
Degree of interest in quitting smoking*				<0.0001
Current daily	75	5.21	0.41	
Current some days	197	5.90	0.26	††
Former	1628	5.58	0.10	‡‡
Never	8637	5.18	0.04	
Total	10537	5.25	0.04	

Current Population Survey Tobacco Use Supplement 2006–2007.

*Respondents were asked to rate their level of interest in quitting smoking on a scale from 1–10, where 1 = not at all interested and 10 = extremely interested.

†Significantly higher than for those who never used snuff, $p = 0.0026$.

‡Significantly higher than for those who formerly used snuff, $p = 0.025$.

§Significantly higher than for those who never used snuff, $p = 0.0072$.

¶Significantly higher than for those who never used snuff, $p = 0.046$.

**Significantly higher than for those who never used snuff, $p = 0.0005$.

††Significantly higher than for those who never used snuff, $p = 0.0067$.

‡‡Significantly higher than for those who formerly used snuff, $p = 0.0001$.

degree of interest in quitting than did daily smokers who did not use snuff.

DISCUSSION

Based on data from four large, US nationally representative surveys of young people or adults, the association between smokeless tobacco use and cigarette smoking is complex. The prevalence of smoking is generally quite high among men who use snuff on a less-than-daily basis and among former snuff users, while the prevalence of smoking is relatively low among men who use snuff every day. The pattern is quite different for young people: the prevalence of daily smoking is very high among male students in middle school and high school who use smokeless tobacco. This pattern is consistent with findings from an earlier US nationally representative prospective cohort study, which found that early dual users largely moved towards cigarette smoking later in life.¹¹

A number of indications in this study reflect a potentially troubling pattern of smoking associated with non-daily ST use: ‘some day’ snuff users are more likely to be current daily smokers than any other group, and daily smokers who also use snuff on some days expressed greater interest in quitting smoking than the other groups but were more likely than any other group to have had unsuccessful quit attempts in the preceding year. This pattern of tobacco use may represent a partial substitution of smoking and a prolonging of dependence. Conversely, it is possible that smokers who have had unsuccessful quit attempts subsequently turned to snuff as a cessation strategy. Understanding the reasons for dual use clearly requires further research.

Although dual daily use of ST and cigarettes is relatively uncommon, that pattern is more common among adolescents and young adults than among more mature tobacco users. Although male dual daily users tend to smoke fewer cigarettes per day than male daily smokers who do not use snuff or use it less than daily, they tend to have the highest levels of serum cotinine and exhibit among the most prevalent indicator of dependence.

Interestingly, daily smokers who also used snuff on a non-daily basis had serum cotinine levels that were essentially equivalent to those of daily smokers who never used snuff, although there was no significant difference in the number of cigarettes they smoked per day. It is not known whether that pattern reflects their infrequency of snuff usage, greater compensation among smokers whose only source of nicotine was cigarettes, biological factors such differences in nicotine metabolism, or the relatively imprecise estimates that resulted from small sample sizes.

The landscape of tobacco use is rapidly changing in the USA. Per capita cigarette consumption has reached its lowest point in more than 60 years,¹² smoking among high school students is at its lowest level since tracking began⁹ and smoke-free indoor regulations continue to proliferate.^{13,14} However, sales of moist snuff in the USA continue to increase each year.¹ In stark contrast to the situation that existed in the USA until 2006, when almost the entire smokeless tobacco market was controlled by companies that did not manufacture cigarettes, cigarette manufacturers now control virtually the entire US snuff market. There is no indication that the major tobacco companies are planning to abandon cigarette manufacturing; on the contrary, they appear to be positioning traditional and new types of ST products as complements and as situational substitutes for cigarettes.¹⁵ The most recently available data suggest that dual product use is primarily concentrated in regions and subpopulations of the USA where ST use has been relatively prevalent for many years—for example, young males in southern and

Appalachian states, northern plain states and in non-metropolitan areas. With tobacco companies such as Reynolds American, Philip Morris USA, Liggett and Lorillard focusing their test marketing efforts on areas with large college student populations, such as Columbus, Ohio and Austin, Texas and large urban areas with recent smoke-free indoor air laws, such as Indianapolis, Portland and Orlando,^{16–18} dual use of cigarettes and ST may become more prevalent in other regions.

Our findings are consistent with other US studies on dual use of ST and cigarettes. An earlier analysis of 1998 National Health Interview Survey data also found a high prevalence of smoking among men who used ST on some days, and indications that some men were using ST as a way to quit smoking.⁵ Similar to our findings, previous analyses of the 2002 and 2004 National Youth Tobacco Surveys found that a large proportion of young people who smoked also used other tobacco products.⁸ An earlier study of dual product users also reported profound levels of tobacco dependence.¹⁹ The present study extends these previous studies by examining these patterns in greater detail across multiple age groups and modes of data collection.

There are several limitations inherent in the use of the datasets analysed for this study. First, all of the studies used cross-sectional designs, which limits the ability to examine longitudinal patterns of transition between usage of tobacco products. Differences in patterns of dual use between young people and adults may reflect birth cohort effects, and future patterns of tobacco use among adults may differ as today's young people progress through life. In addition, all surveys, with the exception of NHANES, rely only on self-report to estimate prevalence and consumption of tobacco products. Self-reported levels of tobacco consumption may be prone to error.^{20–22} However, such measurement error would be expected to be non-differential with respect to use of other tobacco products—for example, we have no reason to believe that smokeless tobacco users would differ from non-users in the accuracy of their reported daily cigarette consumption. Non-differential measurement error would tend to attenuate the strength of association between smokeless tobacco use and cigarette smoking.

In conclusion, analyses of data from four nationally representative surveys indicate that dual use of cigarettes and ST is relatively common among young males. The pattern is different among adult males, among whom daily smoking predominates and non-daily snuff use is very strongly associated with current smoking. Adult male smokers who also use snuff tend to have relatively high levels of serum cotinine and high prevalence of a major indicator for tobacco dependence. The major US cigarette companies now control nearly the entire US smokeless tobacco market and aggressively promote dual product use, which may portend a lessening in the decline in smoking, increased dual use, perpetuation of dependence and continued high levels of tobacco related death and disease.

What is already known on this subject?

In the USA, cigarette smoking is declining, consumption of moist snuff is increasing and cigarette manufacturers now control nearly the entire moist snuff market. Manufacturers have developed new products that represent cigarette brand extension and are promoting dual use of cigarettes and snuff. No previous US studies have examined detailed patterns of dual use across multiple population-based data sources on the eve of the cigarette industry's takeover of the moist snuff market.

What this study adds?

This study found that the prevalence of daily smoking is very high among male students in middle school and high school who use smokeless tobacco. The prevalence of smoking is generally quite high among adult males who use snuff on a less-than-daily basis and among former snuff users, while the prevalence of smoking is relatively low among men who used snuff every day. The study also found that adult male daily smokers who also use snuff on some days expressed greater interest in quitting smoking than other groups but were more likely than any other group to have had unsuccessful quit attempts in the preceding year. Although male dual daily users tend to smoke fewer cigarettes per day than male daily smokers who do not use snuff or use it less than daily, they tend to have the highest levels of serum cotinine and exhibit among the most prevalent indicator of dependence. The association between smokeless tobacco use and cigarette smoking is complex, and aggressive marketing of moist snuff by cigarette manufacturers may lead to unpredictable and undesirable public health outcomes.

Acknowledgements The authors wish to thank the reviewers for their helpful suggestions on an earlier version of this manuscript.

Funding This study was supported by National Cancer Institute grant R01CA87477 (GNC, principal investigator).

Competing interests SLT serves as an expert witness for plaintiffs in product litigation brought against cigarette and smokeless tobacco manufacturers.

Ethics approval This study was approved by the institutional review boards of Harvard University and the University of Florida Health Science Center.

Contributors All authors included on this paper fulfil the criteria of authorship. We also confirm that there is no one else who fulfils the criteria but has not been included as an author.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

1. **Federal Trade Commission.** *Smokeless tobacco report for the year 2006.* Washington, DC: Federal Trade Commission, 2009.
2. **Statistics Sweden.** *Use of alcohol and tobacco. Official Statistics of Sweden. Living Conditions Report No. 114.* Stockholm: Statistics Sweden, Unit of Social Welfare, 2007.
3. **Reynolds American.** Reynolds American completes acquisition of Conwood [press release]. 2006 <http://www.reynoldsameric.com/Newsroom/%5Ccommon%5CViewHTML.aspx?postID=1146>.
4. **Altria Group Inc.** Altria Group, Inc. agrees to acquire UST Inc, world's leading moist smokeless tobacco manufacturer, for \$69.50 per share in cash [press release]. 2008 http://www.altria.com/media/02_00_NewsDetail.asp?reqid=1194435.
5. **Tomar SL.** Snuff use and smoking in US men: implications for harm reduction. *Am J Prev Med* 2002;**23**:143–9.
6. **Mumford EA,** Levy DT, Gitchell JG, *et al.* Tobacco control policies and the concurrent use of smokeless tobacco and cigarettes among men, 1992–2002. *Nicotine Tob Res* 2005;**7**:891–900.
7. **Bombard JM,** Pederson LL, Nelson DE, *et al.* Are smokers only using cigarettes? Exploring current polytobacco use among an adult population. *Addict Behav* 2007;**16**:318–24.
8. **Bombard JM,** Rock VJ, Pederson LL, *et al.* Monitoring polytobacco use among adolescents: do cigarette smokers use other forms of tobacco? *Nicotine Tob Res* 2008;**10**:1581–9.
9. **Johnston LD,** O'Malley PM, Bachman JG, *et al.* *Monitoring the Future national survey results on drug use, 1975–2007. Volume I: Secondary school students.* Bethesda, MD: National Institute on Drug Abuse, 2008.
10. **Fagerstrom K.** Time to first cigarette; the best single indicator of tobacco dependence? *Monaldi Arch Chest Dis* 2003;**59**:91–4.
11. **Zhu SH,** Wang JB, Hartman A, *et al.* Quitting cigarettes completely or switching to smokeless tobacco: do US data replicate the Swedish results? *Tob Control* 2009;**18**:82–7.
12. **U.S. Department of Agriculture.** *Tobacco outlook. TBS-263.* Washington, DC: U.S. Department of Agriculture, Economic Research Service, 2007.

13. **U.S. Department of Health and Human Services.** *The health consequences of involuntary exposure to tobacco smoke: a report of the Surgeon General.* Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Coordinating Center for Health Promotion, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2006.
14. **American Nonsmokers' Rights Foundation.** *Chronological table of US population protected by 100% smokefree state or local laws, January 4, 2009.* Berkeley, CA: American Nonsmokers' Rights Foundation, 2009.
15. **Carpenter CM,** Connolly GN, Ayo-Yusuf OA, *et al.* Developing smokeless tobacco products for smokers: an examination of tobacco industry documents. *Tob Control* 2009;**18**:54–9.
16. **Craver R.** RJR adds test cities: smokeless snus 'gaining traction'. *Winston-Salem Journal* 21 April 2008. Available from: <http://www2.journalnow.com/content/2008/apr/12/rjr-adds-test-cities/> (accessed 10 February 2010).
17. **Liggett Group.** *Liggett Group to introduce Grand Prix Snus [press release].* Mebane, NC: Liggett Group, 2008.
18. **Philip Morris USA.** *Philip Morris USA announces expansion of Marlboro Snus into new test market [press release].* Richmond, VA: Philip Morris USA Media Relations, 2008.
19. **Wetter DW,** McClure JB, de Moor C, *et al.* Concomitant use of cigarettes and smokeless tobacco: prevalence, correlates, and predictors of tobacco cessation. *Prev Med* 2002;**34**:638–48.
20. **Perez-Stable EJ,** Benowitz NL, Marin G. Is serum cotinine a better measure of cigarette smoking than self-report? *Prev Med* 1995;**24**:171–9.
21. **Caraballo RS,** Giovino GA, Pechacek TF, *et al.* Factors associated with discrepancies between self-reports on cigarette smoking and measured serum cotinine levels among persons aged 17 years or older: Third National Health and Nutrition Examination Survey, 1988-1994. *Am J Epidemiol* 2001;**153**: 807–14.
22. **Kandel DB,** Schaffran C, Griesler PC, *et al.* Salivary cotinine concentration versus self-reported cigarette smoking: three patterns of inconsistency in adolescence. *Nicotine Tob Res* 2006;**8**:525–37.